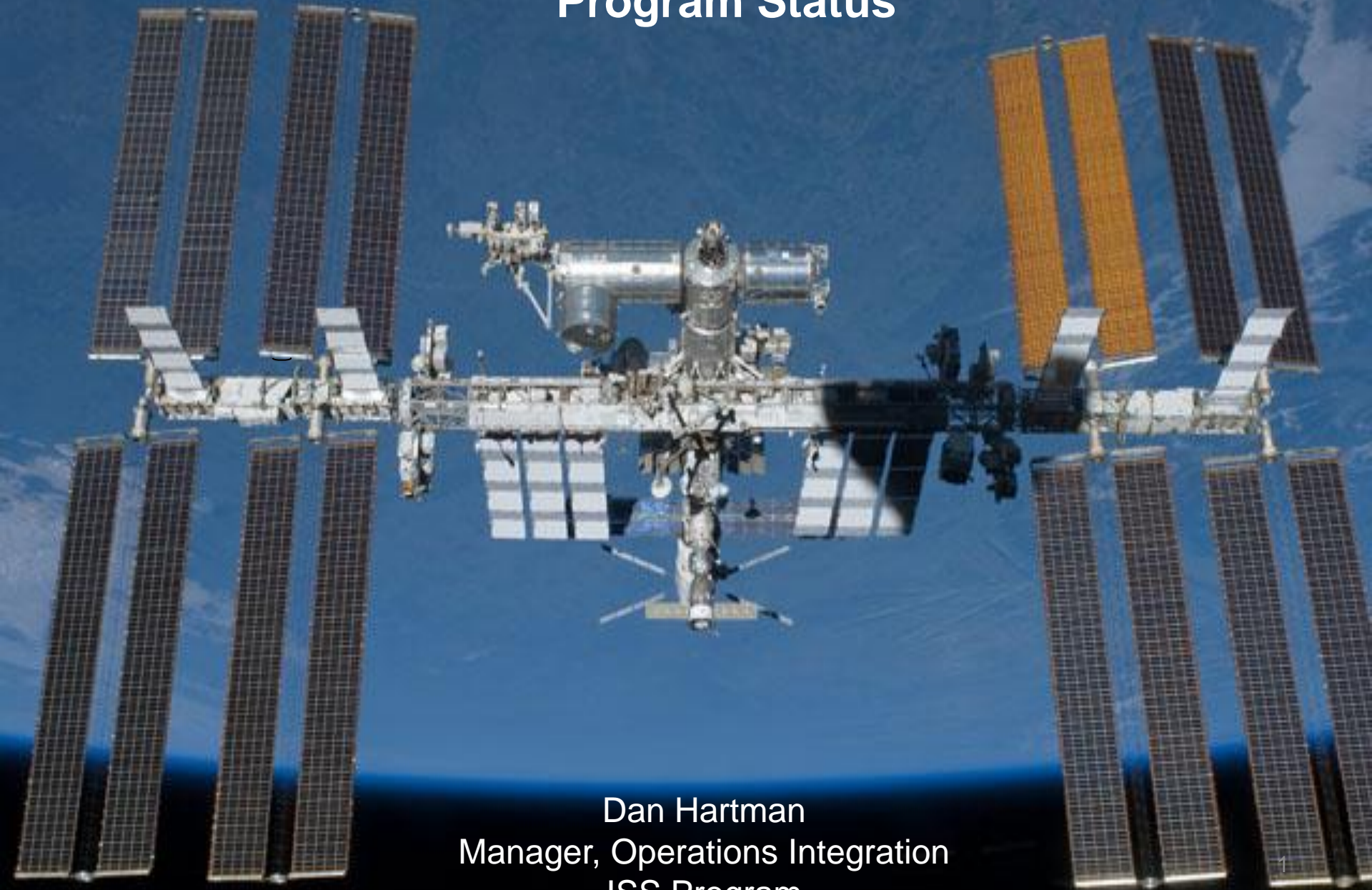
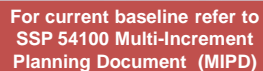


International Space Station Program Status



Dan Hartman
Manager, Operations Integration
ISS Program



NASA Official: John Coggeshall
Prepared by: Scott Paul
Chart Updated: July 11, 2012
SSCN/CR: 13330 (Baseline)

2012												2013												2014					
Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar						
Inc		Inc 31		Inc 32		Inc 33		Inc 34				Inc 35		Inc 36				Inc 37		Inc 38				Inc 39					
N (28S)	R G. Padalka (CDR-32)	125 days		(30S)		N K. Ford (CDR-34)	155 days				R P. Vinogradov (CDR-36)	167 days				(34S)	R O. Kotov (CDR-38)	168 days				(36S)							
R (28S)	R S. Revlin	125 days		(30S)		R O. Novitskiy	155 days				(32S)	R Misurkin	167 days				(34S)	R S. Ryazansky	168 days				(36S)						
R (28S)	N J. Acaba	125 days		(30S)		R E. Tarelkin	155 days				(32S)	N Cassidy	167 days				(34S)	N M. Hopkins	168 days				(36S)						
R Kononenko (CDR-31)		(29S)	N S. Williams (CDR-33)		120 days		(31S)	C C. Hadfield (CDR-35)				161 days				(33S)	R F. Yurchikhin (CDR-37)				170 days		(35S)	J K. Wakata (CDR-39)		168 days			
K Kuipers 193 days		(29S)	R Y. Malenchenko		120 days		(31S)	R R. Romanenko				161 days				(33S)	N K. Nyberg				170 days		(35S)	N R. Mastracchio		168 days			
N Pettit 193 days		(29S)	J A. Hoshida		120 days		(31S)	N T. Marshburn				161 days				(33S)	A L. Parmitano				170 days		(35S)	R M. Tyurin		168 days			
</																													



Increment 32 Overview



Yuri Malenchenko
Sunita Williams
Aki Hoshide (JAXA)
(Soyuz TMA-05M)

Joe Acaba
Gennady Padalka
Sergei Revin
(Soyuz TMA-04M)



Recent Mission Accomplishments thru June 2012 (last 4 months)



- Successful Vehicle traffic at the ISS
 - March/April : ATV-3 dock 3/28, 46P undock 4/19, 47P docking 4/22, 28S undock 4/27
 - May/June : 30S Docking 5/19, SpaceX Demo berthing 5/25, SpaceX Demo unberth 5/31, 29S undock 6/30
 - July 17 31S docking
- Successful demonstration of SpaceX Demo vehicle objectives
 - Track and capture, berthing, cargo operations, unberth and release of first commercial vehicle to the ISS.
- Averaged 35 hours/week for research last Increment
 - Continued checkout of Robonaut
 - Robotic Refueling Mission (RRM) operations part 2
 - AMS detected 19 billionth cosmic particle
- Reacted to several system anomalies (JEM low temp pump, CDRA sensors and valves, Water Processor leak, GPS box failures)

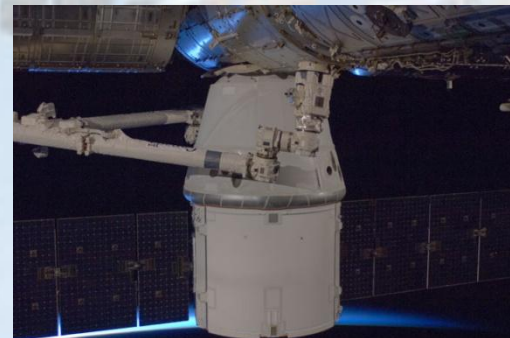


Transit of Venus as seen by the ISS crew.

Expedition 31 Crew



SpaceX Dragon, berthed at N2 Nadir





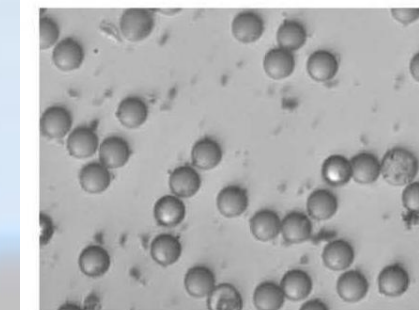
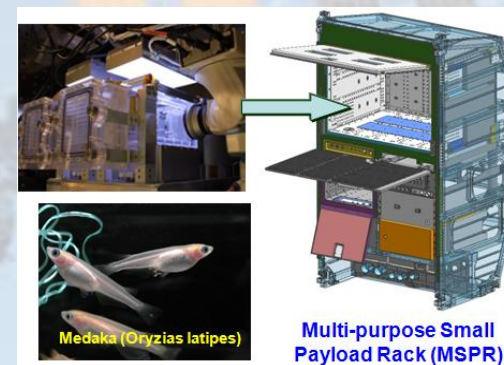
Mission Objectives July 2012 – October 2012



- Support upcoming vehicle traffic : 47P undocking, re-rendezvous, docking, and undocking, 48P docking, HTV3 berthing, 30S undock, HTV-3 unberth, ATV-3 undock, SpaceX-1 berthing, 32S docking
- Perform RS EVA #31 (MMOD shields on SM, launch Spherical Satellite, collect [CKK] and Biorisk) and USOS EVA #18 (R&R MBSU1, route MLM cables, install PMA2 cover), both scheduled in August
- Transition to the WRS Water Recovery System (WRS) re-usable Advanced Recycle Filter Tank Assembly (ARFTA), which reduces need for delivery and disposal of consumables for nominal operations
- New science delivered on HTV3 and 48P
 - Advanced Colloids Experiment-1 (ACE-1)
 - Aquatic Habitat
 - ISS SERVIR Environmental Research and Visualization System (ISERV)
 - Multi-mission Consolidated Equipment (MCE)
 - Plate Reader
 - Space Communications and Navigation (SCAN) Testbed
 - Small Sat Deploy Demo
 - YouTube Space Lab
 - Spacecraft Single Event Environments at High Shielding Mass (HiMassSEE): HiMassSEE
 - Radiation Environment Monitor (REM)



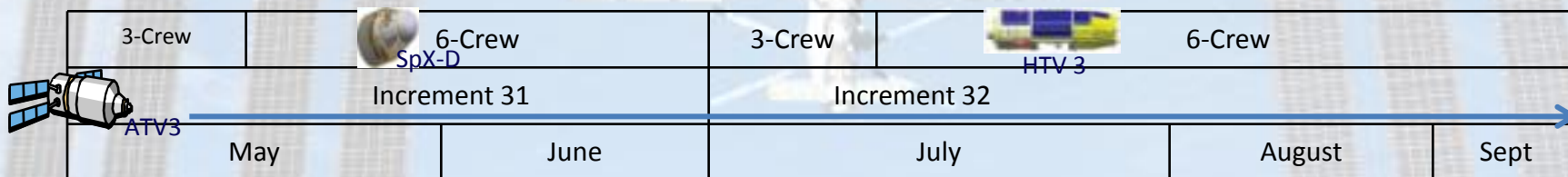
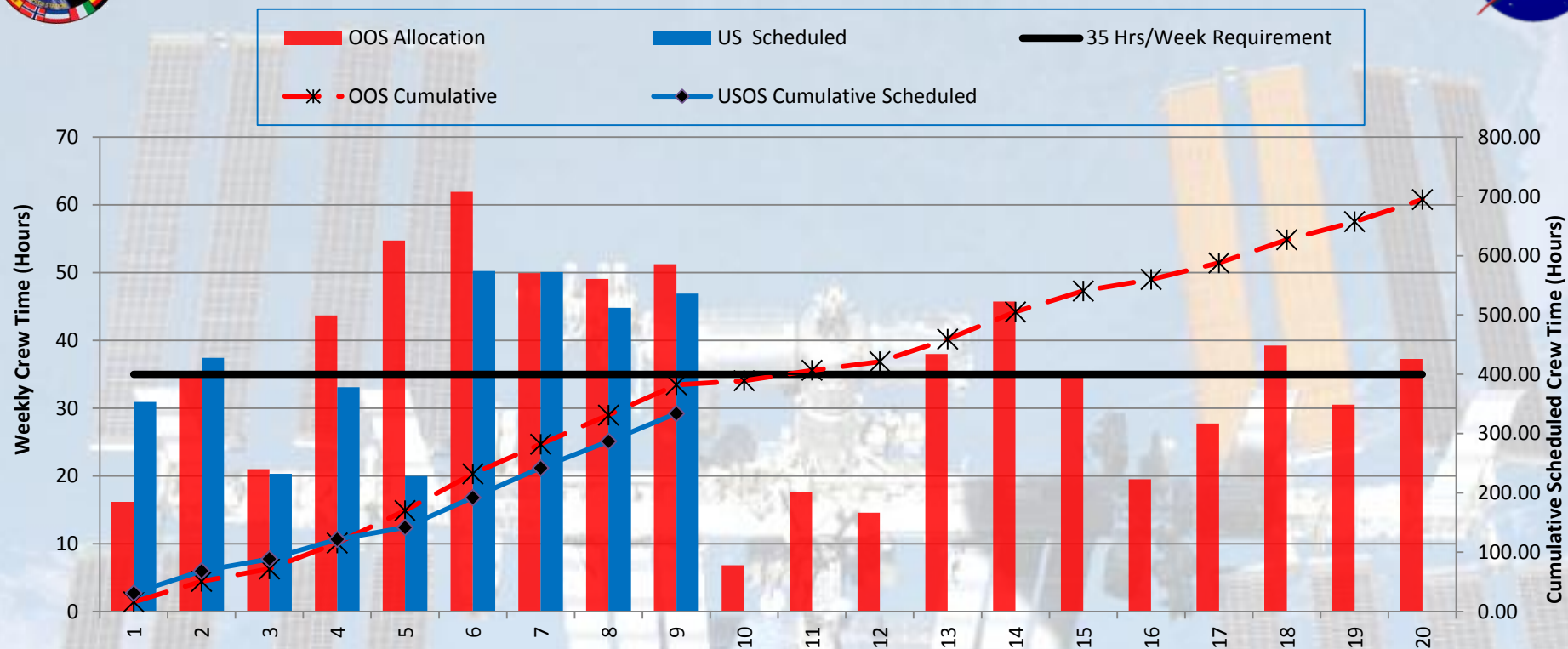
SCAN testbed



ACE-1



Increment 31 / 32 Utilization Crew Time



Week 9 of 20, 45% through the Increment

USOS Allocation (IDRD) : 686 Hours
USOS Actuals : 334 Hours

Total USOS Average Per week : 37.1 Hours



Expeditions 31/32

- 201 Investigations
 - 123 new investigations
 - 82 NASA-led investigations
 - 119 International-led investigations
 - Over 400 Investigators represented
 - Over 500 scientific results publications (Exp 0 – present)

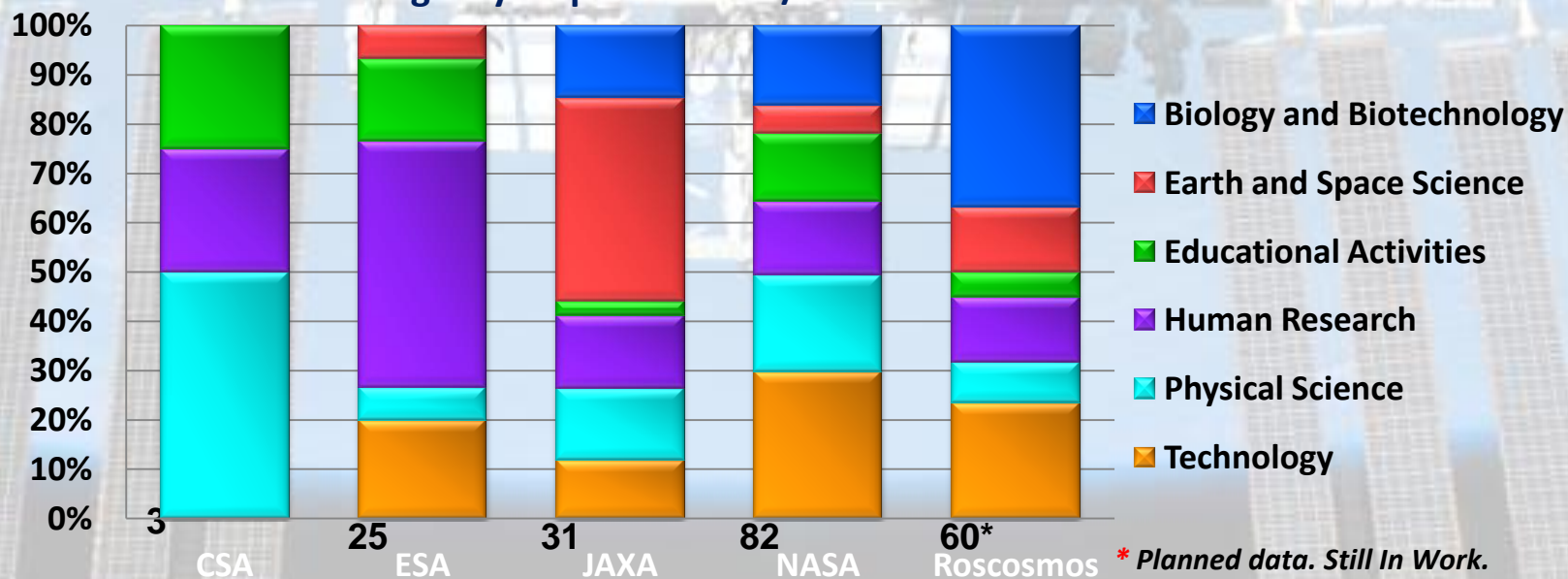
Expeditions 0 – 28

- 1251 Investigations
 - 475 NASA-led investigations
 - 776 International-led investigations
 - > 1300 scientists served

Expeditions 29/30

- 191 Investigations
 - 85 NASA-led investigations
 - 106 International-led investigations
 - > 400 scientists served

Research Disciplines of ISS Investigations By Partner Agency: Expeditions 31/32



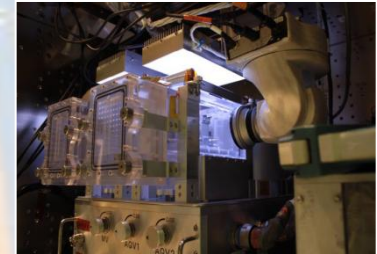


HTV Ascent: New Research

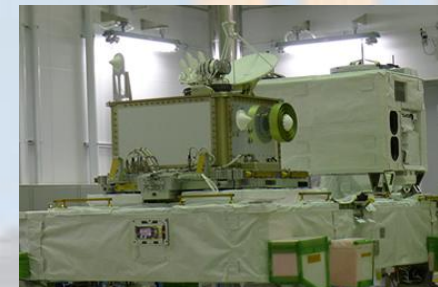


Aquatic Habitat will be located in MSPR and support multigenerations of medaka and zebrafish in studies that investigate the effects of microgravity on bone, muscle, radiation physiology, and development

Aquatic Habitat

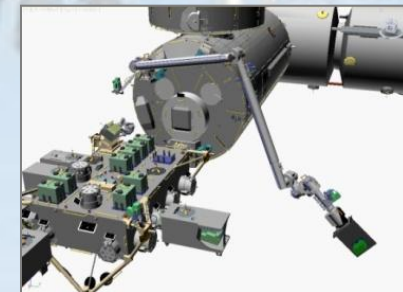


Space Communications and Navigation (SCaN) Testbed: provides a platform for 3 Software Defined Radios (SDRs) in the Ka, L, and S bands to optimize software and firmware configurations, while communicating via RF links with the TDRSS and GPS satellite constellations and Near Earth Network



SCaN

JEM Small Satellite Orbital Deploy (JSSOD): This technology demonstration will evaluate the capability to deploy 5 (3 JAXA and 2 NASA) Small Satellites (i.e. Cubesats) from the ISS via the JEM SSRMS



JSSOD

SERVIR Environmental Research and Visualization System (ISERV): ISERV is a pathfinder Earth imaging system that will be located in WOLF. The goal is test operational techniques and data acquisition capabilities that will drive future remote sensing instruments critical to understanding global climate and population changes, disaster assessment, and ecology

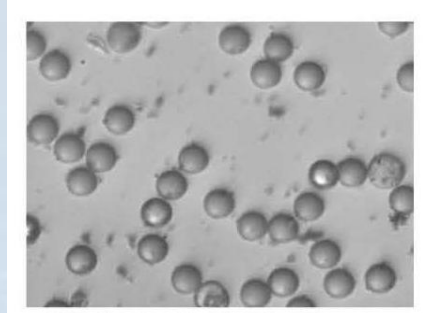


ISERV



Advanced Colloids Experiment-1 (ACE-1): ACE-1 is the first in a series of microscopic imaging investigations that seek to understand the behavior of colloid interactions over time. ACE-1 will use the existing Light Microscopy Module (LMM) hardware in the Fluids Integrated Rack (FIR)

NanoRacks Plate Reader is a modified commercial research facility that spectroscopically analyzes sample microplate or sample cuvettes on-orbit. Plate Readers are standard data analysis capabilities on Earth among laboratories ranging from materials science to biology and chemistry



ACE-1



Plate Reader

Global Education

A photograph of two young students, a boy and a girl, both wearing yellow shirts, leaning over a desk in a classroom. They are looking at a large map or worksheet. The boy is holding a pencil and writing on a clipboard. The girl is pointing at the map. In the background, other students in yellow shirts are seated at desks, also working. The classroom has a carpeted floor and wooden desks.

Education – *International Space Station* research has involved over 900,000 students in the U.S, and over 41 million more have participated in educational demonstrations performed by crewmembers onboard ISS.



Total ISS Consumables Status: Total On-orbit Capability 10-July-12 48P SORR, 48P (Dock 2-Aug-12)



	T3: Current Capability with 48P		T4: Current Capability with HTV3 and 48P	
Consumable – based on current, ISS system status	Date to Reserve Level	Date to zero supplies	Date to Reserve Level	Date to zero supplies
Food – 100% (1) (2)	February 27, 2013	April 20, 2013	March 17, 2013	May 8, 2013
KTO (2)	October 19, 2013	December 11, 2013	April 3, 2014	May 21, 2014
Filter Inserts	June 30, 2014	August 14, 2014	June 30, 2014	August 14, 2014
Toilet (ACY) Inserts (2)	February 17, 2014	April 11, 2014	February 17, 2014	April 11, 2014
EDV (UPA Operable) (2) (3) (4)	May 10, 2013	July 26, 2013	May 10, 2013	July 26, 2013
RFTA (4) (5)	July 24, 2012	August 24, 2012	July 24, 2012	August 24, 2012
Consumable - based on system failure				
EDV (UPA Failed) (2) (3)	March 4, 2013	April 25, 2013	March 4, 2013	April 25, 2013
Water, if no WPA (Ag & Iodinated) (2) (6)	March 18, 2013	May 10, 2013	March 18, 2013	May 10, 2013
O ₂ if Elektron supporting 3 crew & no OGA (2) (7)	December 31, 2012	May 10, 2013	December 31, 2012	May 10, 2013
O ₂ if neither Elektron or OGA (2) (7)	August 26, 2012	November 8, 2012	August 26, 2012	November 8, 2012
LiOH (8) (CDRAs and Vozdukh off)	~ 6.4 days	~20.4 days	~ 6.4 days	~20.4 days

Dock Dates: 31S / 17-JULY-12

HTV3 / 27-JULY-12

48P / 2-AUG-12

SpX-1 / 7-OCT-12

(1) Includes food on Soyuz; after RS goes to zero, both sides share USOS food. (2) Reserve level to Zero is different than 45 days due to varying crew size. (3) Progress and ATV tanks included in assessment for urine dumping only. (4) Currently utilizing remaining RFTAs. Assumes return to A-RFTA after RFTA run-out. (5) Assumes no RS urine processing. Assumes 70% recovery rate. RFTA reserve date indicates one RFTA remaining. (6) RS processes all condensate in event of WPA failure. (7) Includes metabolic O₂ for 45 day/6-crew reserve and the O₂ for greater of CheCs or 4 contingency EVAs. (8) LiOH Canisters will be used for CO₂ removal from the ISS if the CDRAs are inoperable. Total LiOH Reserve Level is 14 days for 6 crew. (Reserve Level for USOS LiOH is ~13.3 days for 3 crew (20 canisters), and for RS LiOH is 15 days for 3 crew (15 canisters).)



USOS ISS Consumables Status: USOS On-orbit Capability

10-July-12 48P SORR, 48P (Dock 2-Aug-12)



Consumable – based on current, ISS system status	U3: Current Capability with 48P		U4: Current Capability with HTV3 and 48P	
	Date to Reserve Level	Date to zero supplies	Date to Reserve Level	Date to zero supplies
Food – 100% (1)	July 3, 2013	August 17, 2013	August 10, 2013	September 28, 2013 (2)
KTO	August 5, 2014	September 20, 2014	July 3, 2015	August 17, 2015
Filter Inserts	July 19, 2015	September 2, 2015	July 19, 2015	September 2, 2015
Toilet (ACY) Inserts (2)	March 9, 2015	April 29, 2015	March 9, 2015	April 29, 2015
EDV (UPA Operable) (2) (3) (4)	July 29, 2013	February 13, 2014	July 29, 2013	February 13, 2014
RFTA (4) (5)	July 24, 2012	August 24, 2012	July 24, 2012	August 24, 2012
Consumable – based on system failure				
EDV (UPA Failed) (3)	December 18, 2012	February 1, 2013	December 18, 2012	February 1, 2013
Water, if no WPA (Ag & Iodinated)	December 14, 2012	January 28, 2013	December 14, 2012	January 28, 2013
O₂ if no OGA (2) (6)	October 21, 2012	January 19, 2013	October 21, 2012	January 19, 2013
LiOH (7) (CDRAs off)	~11.3 days	~24.6 days	~11.3 days	~24.6 days

Dock Dates: 31S / 17-JULY-12

HTV3 / 27-JULY-12

48P / 2-AUG-12

SpX-1 / 7-OCT-12

(1) Includes food on Soyuz. **(2)** Reserve level to Zero is different than 45 days due to varying crew size. **(3)** Progress tanks not included in assessment for urine dumping. ATV tanks are included in assessment for urine dumping. **(4)** Currently utilizing remaining RFTAs. Assumes return to A-RFTA after RFTA run-out. **(5)** Assumes no RS urine processing and 70% recovery rate. RFTA reserve date indicates one RFTA remaining. **(6)** Includes metabolic O₂ for 45 day/3-crew reserve and the O₂ for greater of CheCs or 4 contingency EVAs. **(7)** LiOH Canisters will be used for CO₂ removal from the ISS if the CDRAs are inoperable. Reserve Level for USOS LiOH supplies is ~13.3 days for 3 crew (20 canisters).



➤ Enhanced Processing and Integrated Communications (EPIC) Project

- EPIC is an upgrade to the main processor board for the C&C, GN&C, and Payload MDMs.
 - C&C and GN&C EPIC upgrades and software transitions were successfully completed on Jan 5;
 - Payload MDM EPIC upgrades were completed Feb 28-29
 - Eliminated Payload Operations constraint on Payload MDM
- Late anomaly during final ground testing was observed with several EPIC card types
 - Isolated to a component issue, a Pulse Width Modulator (PWM) that generates an on-card voltage
 - Special Test hit flown and utilized prior to installation
 - All onboard tests successful
 - Performance to date has been nominal

Recovers CPU and
memory margins
-Increased processing
-Increased memory



Adds 10/100 BaseTx Ethernet
interface
for on-orbit and ground access to
vehicle system data

On-orbit card level replacement to
existing processor card

EPIC Circuit Card



iPEHG/ICU Status



➤ High Rate Communications System (HRCs) Upgrades

- Improved Payload Ethernet Hub Gateway (iPEHG): Incorporates higher communications rates which allow the Medium Rate Data links to operate at a higher data rate of 100 Mbps versus the current rate of 7 Mbps. **Launch on HTV3 and 48P in July 2012.**
- Integrated Communications Unit (ICU): A single On-Orbit Replacement Unit (ORU) that replaces seven existing communications-related ORUs, providing equivalent and additional function, and enhanced performance. The ICU increase the return and forward link data rates to 300 and 25 Mbps from 150 and 3 Mbps, respectively; records 6 channels of video and all return link data at ~300 Mbps rate; encodes video for reduced bandwidth utilization and improved quality; provides two additional, two-way audio space-to-ground channels; and provides a contingency system command communications capability. **Launch on HTV3 and 48P in July 2012.**

Increased data handling from 7 to 100 Mbps

Form and fit identical to existing PEHG

Increased data channels from 20 to 23

iPEHG

Digital Audio and Video Encoding

Gigabit Ethernet Data Routing

Digital Software Define Radio

Decryption for Commanding ISS via Ku

On-Orbit Card Level Upgradeable

~400 Gigabytes Non-volatile (vs. ~30 Gigabytes volatile) Solid State Mass Memory

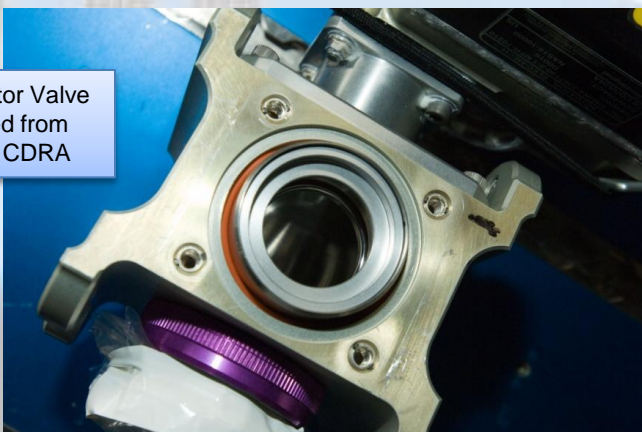
ICU



Carbon Dioxide Removal Assembly (CDRA)



- **LAB CDRA is operational with manual heater control after recent temperature sensor issues.**
 - In June, Lab CDRA failed off several times due to an erratic temp sensor C in Bed 202 (front).
 - Sensors A and B had previously displayed this problem and were by-passed or pinned out.
 - A software patch was implemented on 6/22/12 to allow operation without active heater control.
 - Bed 201 (back) also has an erratic Temperature Sensor B
 - No Spare Beds On-Orbit (Next spare manifested on HTV4 in June 2013)
 - Lab CDRA has also had issues with sticking Air Selector Valves (ASV), but no associated shutdown faults.
- **Node 3 CDRA is shutdown due to intermittent faults with the Air Selector Valves, but available**
 - 3 of the 4 installed ASVs have shown issues, likely associated with the build up of particulates in the valves.
 - Node 3 CDRA will be used as needed until ASV maintenance can be scheduled (approx. 15 hrs).
 - 4 spare ASVs on orbit, including 1 degraded valve that was cleaned on orbit on 5/3/2012
 - Node 3 CDRA also has an erratic Temperature Sensor B in Bed 202 (front) that will be pinned out during the ASV maintenance
- **Russian Segment Vozdukh pump failed July 9th (well past life), spare installed, nominal operations since**



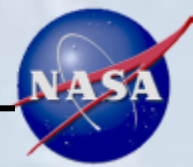
Air Selector Valve
removed from
Node 3 CDRA



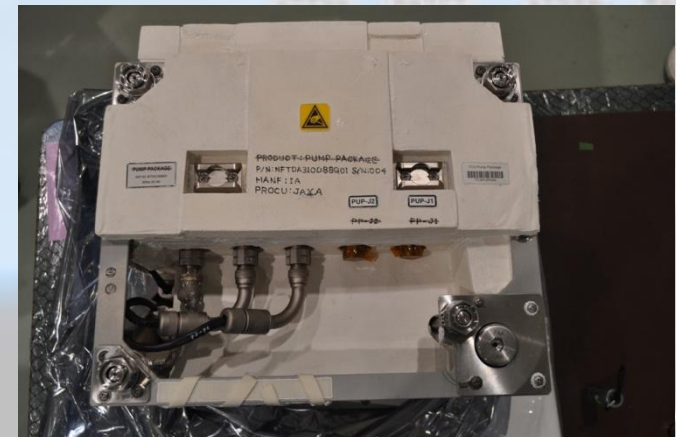
A minimal amount of dust
was seen on
disassembled ASV



JEM Internal Thermal System



- **RPC upstream of the Thermal Control Assembly (TCA) L pump inverter tripped on 3/26 taking down the JEM Low Temperature Loop (LTL) water coolant pump**
 - The JEM transitioned to B1WCL (i.e. single loop operating on the Moderate Temperature Loop (MTL) pump)
- **A series of troubleshooting attempts has been conducted to identify the cause**
 - Resistance measurements on 6/27 and 6/28 confirmed that the fault is in the pump and not in the upstream electronics or harnesses
- **The JEM continues to operate in B1WCL supporting all necessary system loads and payloads**
- **Failure of the MTL pump will, however, require the JEM to transition to the Minimum Keep-alive Configuration (MKAC)**
- **PROX ops for HTV arrival can be supported in MKAC**
 - Reconfiguration of the PROX system will be required to reduce thermal loads
 - The crew will also need to set up a Portable Fan Assembly (PFA) and ducting to provide air cooling to the PROX
- **External Payload (EP) Operations with JEMRMS cannot be executed if the JEM is in MKAC**
 - EP ops timelines are being evaluated considering an MTL pump failure to determine risks to JEMRMS and Payloads
- **A replacement pump will be delivered on HTV-3 and R&R as soon as the task can be worked into the timeline**





SpaceX Demonstration Mission



❑ SpX Demo Mission successfully met all necessary ISS cargo demonstration activities

- Launched successfully on 5/22
- Completed successful ISS Flyunder on 5/23
 - All free flyer demonstration requirements fully met
- Performed berthing to ISS on 5/25
- Delivered 525 kg of upmass to ISS and returned 665 kg of downmass from the ISS
- Returned high priority ISS cargo including a Contingency Water Container – Iodine (CWCI) and a Space Integrated GPS (Global Positioning System)/INS (Inertial Navigation System) (SIGI)
- Unberth conducted on 5/31 with de-orbit and splashdown successfully completed on same day
- Retrieval of Dragon capsule from Pacific Ocean completed on 5/31
- Early destow demonstration successfully completed on 6/2
- Nominal cargo handover to CMC was completed from 6/13 – 6/15
- Final Post Flight Report delivery is planned for early August (Return + 2 months)



SpaceX Demo successfully launched from LC40 on 5/22



Dragon on the barge after being retrieved from Pacific Ocean on 5/31



❑ Orbital Test/Demo Missions

- Completion and turnover for operations of the Wallops Flight Facility (WFF) launch pad is July
 - 5K Cold flow Test Readiness Review (TRR) Phase 1 completed at WFF on 5/15; Phase 2 closeout planned for 7/23
 - 5K test planned following pad handover; 7K hot fire test planned for 8/29
- Test Flight vehicle:
 - Orbital projecting a NET 9/29 Test Flight launch of Anteras
 - Main Engine System Integration to Stage 1 Core has been completed
- Demo:
 - ISS Program official launch date for Demo is 12/12, with Orbital readiness NET 11/22
 - Cygnus Service Module Final Integrated System Test (FIST) completion planned for mid-July
- Safety Review Panel (SRP) Phase III meetings held on 5/23, 6/6, and 6/22 for the Collision Hazard Report
 - Additional reviews in July, with closeout in August
- Software Stage Test (Joint Test 4) scheduled for 8/22-9/12 (dry run completed)
- Joint Multi-Segment Training simulations on-going



Test Flight Core and Engines in HIF being prepped for Launch.

Photo Credits: OSC



ISS Top Program Risk Matrix (Post June 07, 2012 PRAB)



Corrective/Preventative Actions

None

Watch Items

No Watch Items Elevated

Continual Improvement

None

L
I
K
E
L
I
H
O
O
D

5				2	1
4		1	1	2	
3			1	1	2
2		3			1
1					
	1	2	3	4	5

CONSEQUENCE

Low		Medium		High	
C – Cost	S – Schedule	T – Technical	Sa – Safety		
Top Program Risk (TPR)					
Added 6370					
Rescored 2810 & 6198					

Risks (L x C)

Score: 5 x 5

6352 - Overlap in Commercial Crew & Soyuz Launch Services - (OH) - (C,S,T,Sa)

Score: 5 x 4

6344 - ISS Operations Budget Reduction - (OH) - (C)
6370 - ISS Pension Harmonization - (OH) - (C)

Score: 4 x 4

5456 - ISS Budget and Schedule - (OH) - (C,S,T)
6169 - Visual Impairment / Intracranial Pressure - (SA) - (C,S,T,Sa)

Score: 3 x 5

5688 - ISS Solar Array Management Operations Controls and Constraints - (OM) - (C,S,T,Sa)
2810 - Russian Segment (RS) capability to provide adequate MM/OD protection - (OM) - (C,S,T,Sa)

Score: 3 x 4

5184 - USOS Cargo Resupply Services (CRS) Upmass Shortfall - 2010 through 2016 - (ON) - (C,S,T,Sa)

Score: 4 x 3

5269 - The Big 12 Contingency EVA's - (OB) - (S,T,Sa)

Score: 2 x 5

6262 - Potential USOS Nitrogen and Oxygen Resupply Shortfall - (OB) - (C,S,T,Sa)

Score: 3 x 3

6096 - Urine Processing Function - (OB) - (T)

Score: 4 x 2

6347 - Temporary Urine and Brine Stowage System Catastrophic leak of a Tox-2 Fluid - (OB) - (S,T,Sa)

Score: 2 x 2

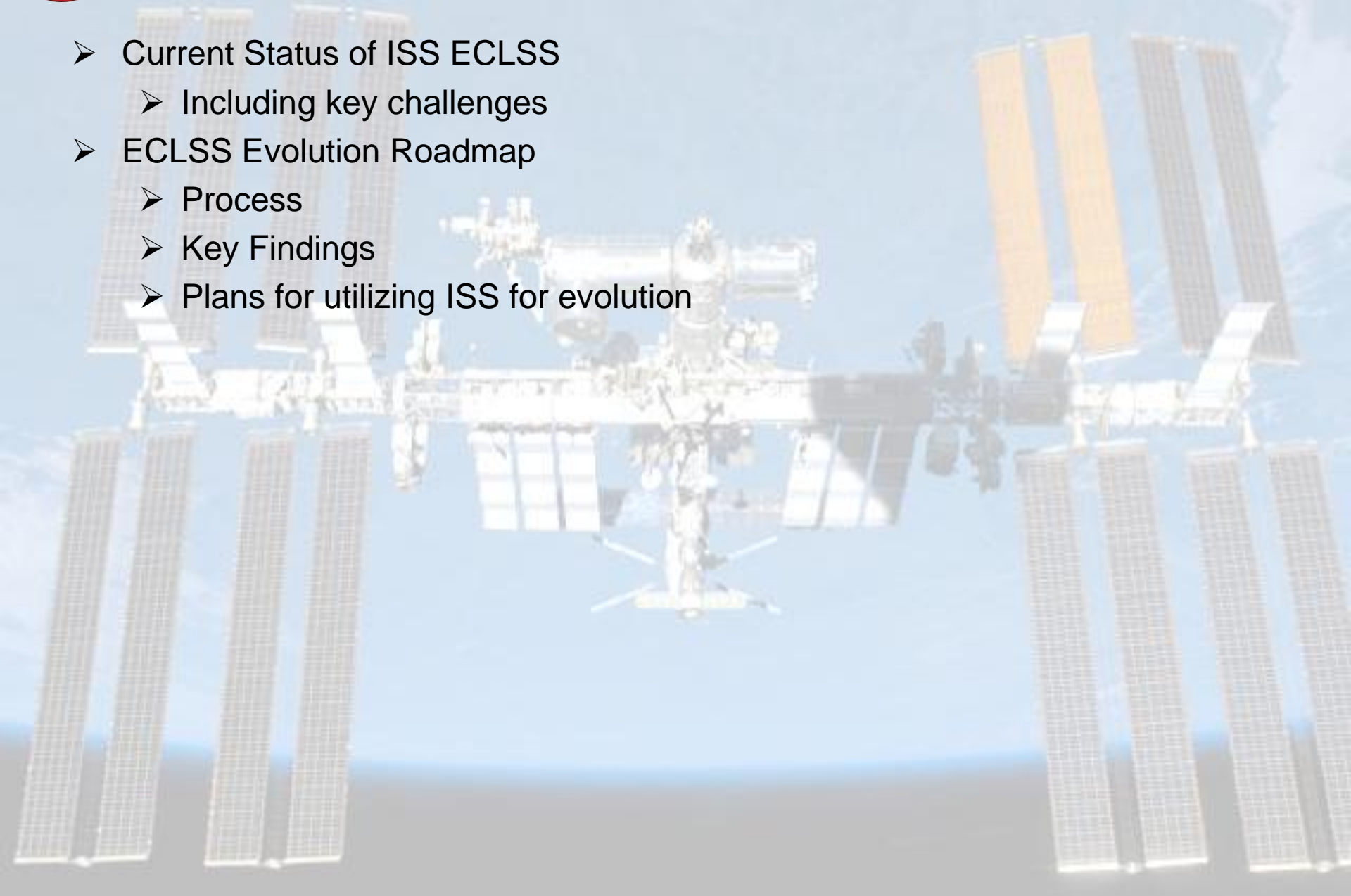
6032 - On-Orbit Stowage Short-Fall (Pressurized Volume) - (OC) - (T,Sa)
6093 - Oxygen Processing Function - (OB) - (C,T)
6198 - ODAR HRCs/ICU Cost Growth - SSCN#11372 - (OD) - (C,S,T)



ISS ECLSS Status and Plans for Evolution

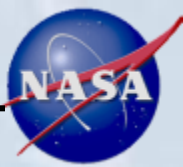


- Current Status of ISS ECLSS
 - Including key challenges
- ECLSS Evolution Roadmap
 - Process
 - Key Findings
 - Plans for utilizing ISS for evolution





Key ISS ECLSS Functions



- Water Recovery
 - Urine Processor Assembly (UPA)
 - Water Processor Assembly (WPA)
- Atmosphere Management
 - Carbon Dioxide Removal Assembly (CDRA)
 - Oxygen Generation System (OGS)
 - Sabatier CO₂ Reduction
 - Major Constituent Analyzer (MCA)
 - Trace Contaminant Control System (TCCS)



Urine Processor Assembly Status



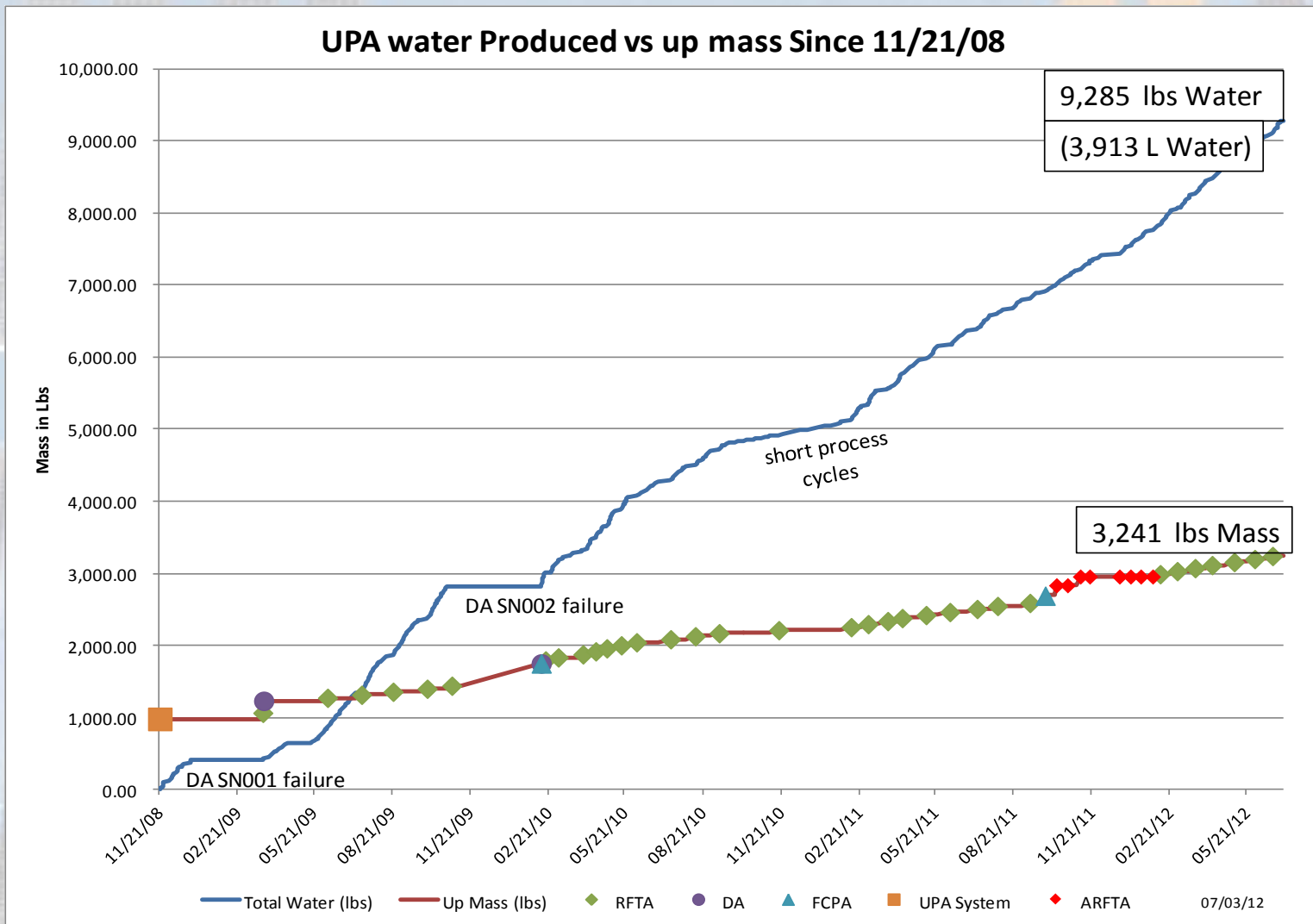
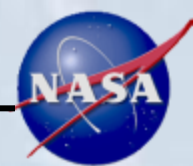
- UPA Status: Operational
 - Processing to 70% recovery (less than 85% design point due to on-orbit calcium precipitation)
- Recycle Filter Tank Assemblies (RFTAs)
 - One available RFTA spare currently on-orbit
 - Last RFTA will be expended by ~end of July
 - Advanced RFTAs (reusable)
 - Install ARFTA mod kit after RFTA's expended
 - Three ARFTA's on-orbit
- Developing options to enable higher actual UPA processing recovery rates (to original design point)
 - Ion Exchange Bed for calcium removal
 - Alternate urine pretreat options to reduce precipitation
- Evolution Needs:
 - Increase % recovery
 - Brine management & water recovery from brine
 - Reliability improvements and expendable reduction



ARFTA Tank On-Orbit



ISS UPA Life Cycle Mass (from startup 11/21/08 through 7/3/12)





Water Processor Assembly Status



- WPA Status: Operational
- Total organic carbon (TOC) in potable water had increased but has returned to nominal levels since R&R of Ion Exchange (IX) Bed in April
 - TOC has been below Total Organic Carbon Analyzer (TOCA) Detection Limit since 23 Apr 12 analysis
 - Samples returned on Soyuz 30S confirmed dimethylsilanediol (DMSD) is again the source of TOC increase (same as in 2010 event)
 - Root Cause is expected to be ineffective removal of DMSD by Multifiltration (MF) Bed and Cat Reactor, causing DMSD saturation in the Ion Exchange (IX) Bed
 - CR is in work to develop media that can more effectively remove DMSD
 - Both MF Beds were returned for refurbishment on SpX Demo flight
 - Pursuing IX Bed return for further investigation on SpX-1
- Evolution Needs:
 - Improve contaminant removal, reduce expendables
 - Improve catalysts, pursue lower temp catalyst



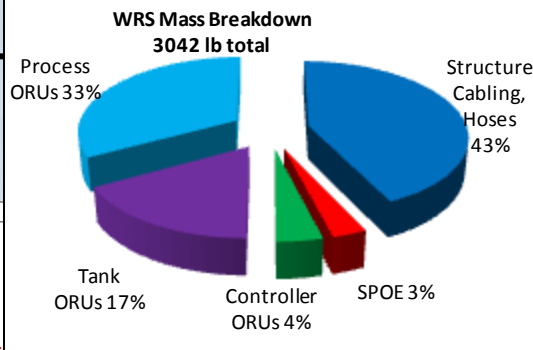
Catalytic Reactor



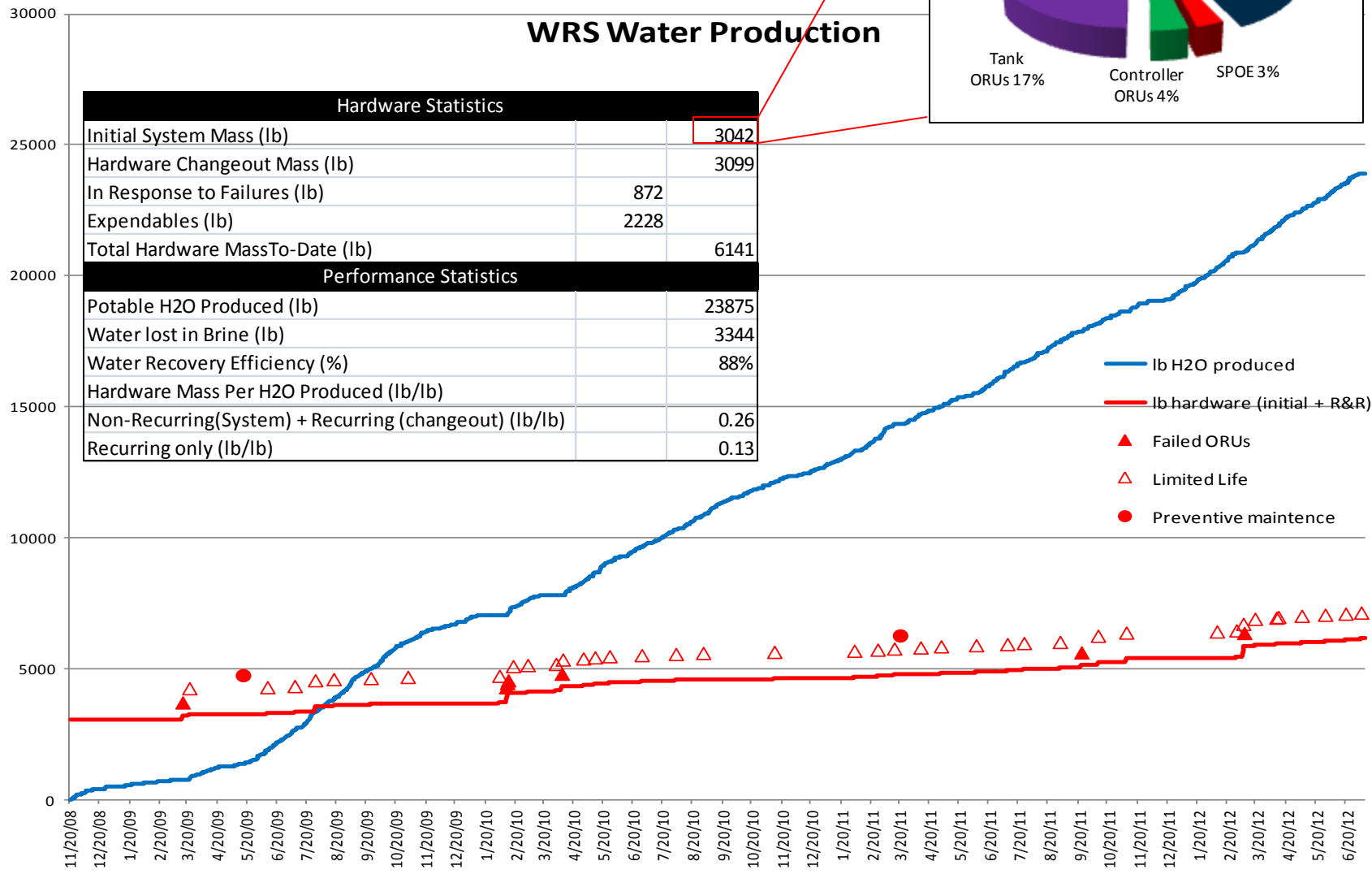
Multifiltration (MF) Bed



ISS WRS Life Cycle Mass (11/20/08 - 7/10/12)



WRS Water Production

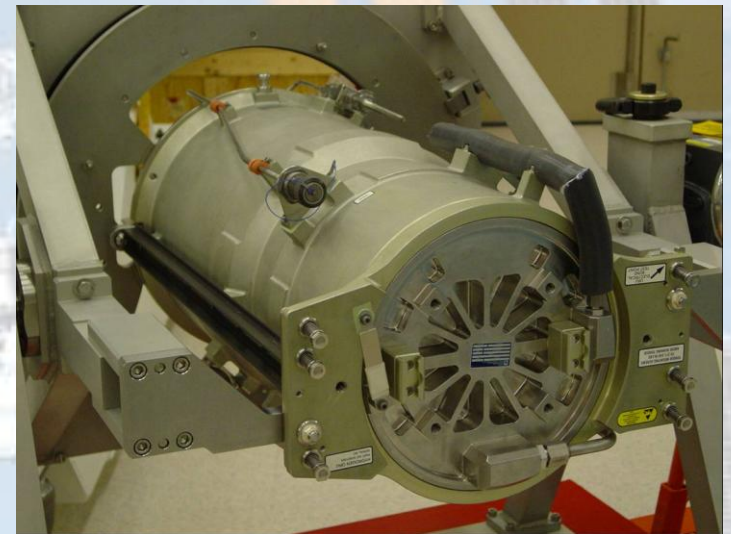




Oxygen Generator Assembly Status



- OGA Status: Operational
 - Remains in STANDBY when not producing O₂
 - Nominally do not exceed 55% production rate
 - Currently operating at 30% production (~3 crew rate)
- Pump ORU degraded (failed dP sensor)
 - Monitoring health via other speed and flow parameters
- Stable operation since installation of the Ion Exchange (IX) cartridge in the water recirculation loop
 - Maintains near-neutral water loop pH by removing acidic biproducts from the cell stack
 - Provides material corrosion controls to prevent contamination issues that led to failure of the first cell stack
- Evolution Needs:
 - Cell membrane which doesn't leach corrosive products
 - Simplification of system through revised hazard analysis, improved reliability

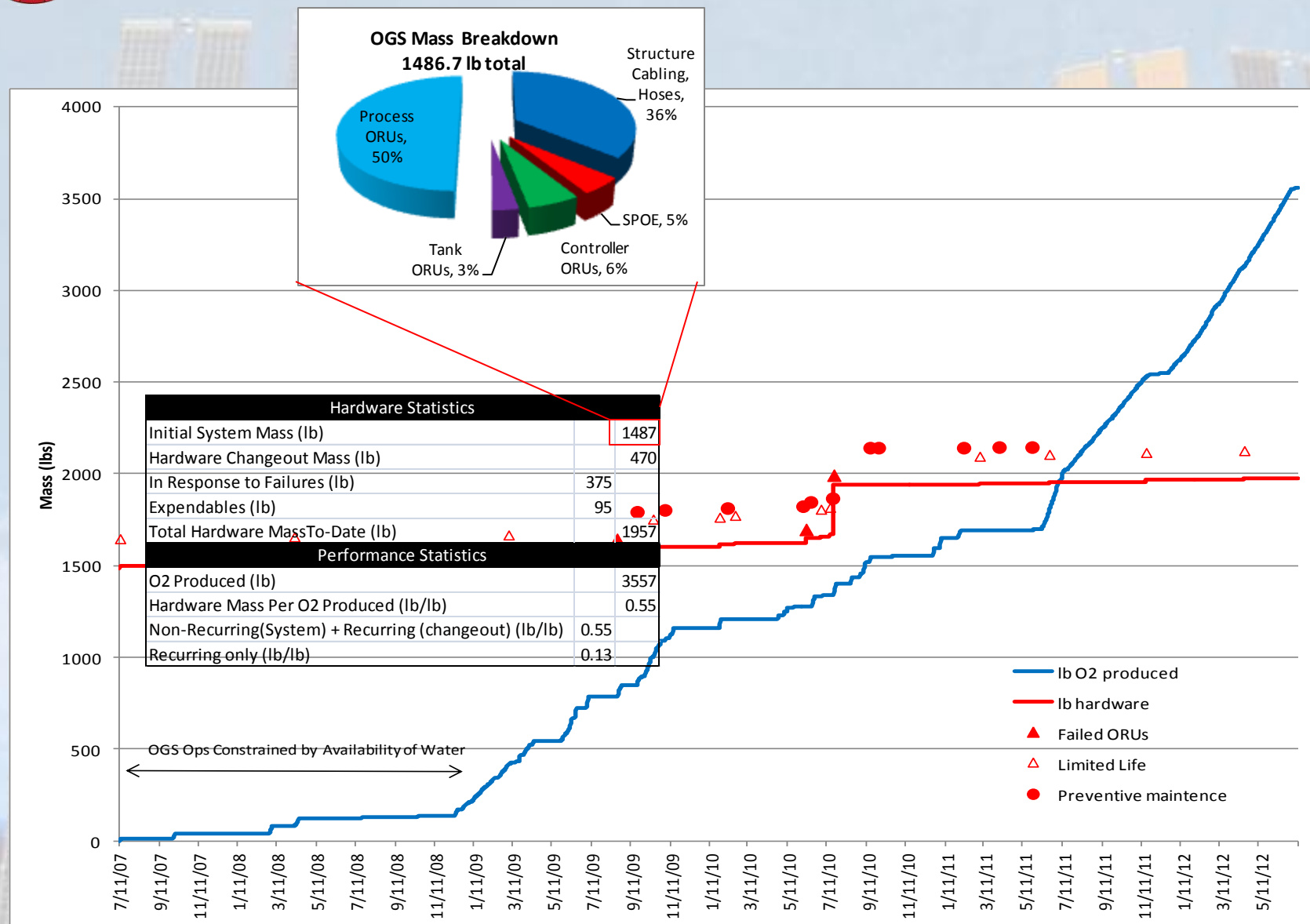


Hydrogen Dome
(contains cell stack)



ISS OGS Life Cycle Mass

(07/11/07 - 7/10/12)

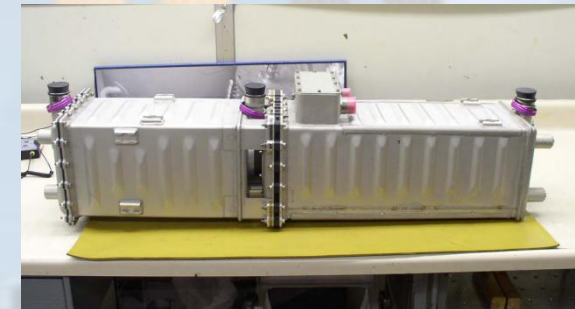




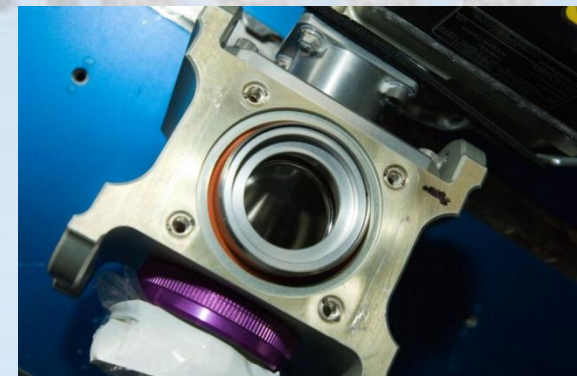
Carbon Dioxide Removal Assembly Status



- Lab CDRA
 - Status: Operational
 - Front DAB operating without temperature sensors due to erratic sensor operation
 - Software changes uploaded on 22 June 12 to allow operation without temperature sensors
 - CDRA activated successfully 22 June 12 with s/w changes in place
 - Stable operation since s/w changes were implemented
 - Rear DAB Temp Sensor B also exhibited erratic operation
 - Faulty sensor pin-out procedure performed on 19 Apr 12
 - 2 active sensors (A & C) remaining
- Node 3 CDRA
 - Status: Degraded
 - Note: Unable to remain in stable operation due to Air Selector Valve (ASV) faults
 - ASV Faults
 - 3 valves (ASV 102, 103, & 104) have caused CDRA shutdown faults
 - Plan to R&R/Move 101, 102, 103, & 104 ASV's pending available crew time
- Evolution Needs:
 - More robust sorbent bed to eliminate dusting and redesign temperature sensors (CR approved; delivery ~mid-2013)
 - Potential need to evolve performance to lower ppCO₂ to more Earth-like conditions (Amine swingbed payload on-orbit demonstration)



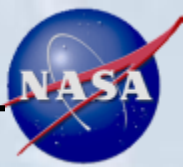
Desiccant/Absorbent
Bed (DAB)



Air Selector Valve
(ASV)



Sabatier CO₂ Reduction Assembly

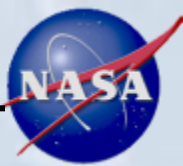


- Status: Intermittent operation based on availability of the OGA and Node 3 CDRA (flown/operated as flight experiment)
 - Briefly activated on-orbit in October 2010 and then shut down due to issues with OGA
 - Re-activated June 2011-March 2012, then shut down due to issues with Node 3 CDRA
 - Generated approximately 177.6 L of water since June 2011
- Recovers ~50% O₂ from CO₂ when operational
- Evolution Needs:
 - Increased recovery of O₂ from CO₂ >50% based on Exploration mission needs. If needed, would require augmentation of Sabatier with methane pyrolysis or alternate CO₂ reduction technology.

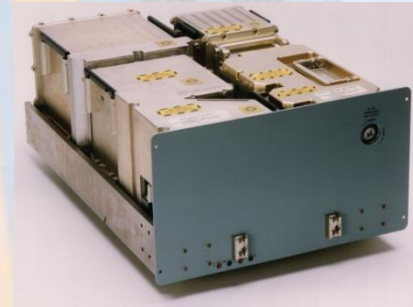




Major Constituent Analyzer



- Lab MCA
 - Status: **Non-Operational**
 - Firmware controller (ORU1) not installed
 - Have spare cards loaded with “old” firmware and “new” style Electronic Data Processor (EDP) card available for I-level maintenance
 - Recent ground testing suggests that these cards will continue to have frequent MCA shut downs
 - Mass Spectrometer (ORU2) not installed
 - ORU 2 removed from Node 3 MCA that is near end of life with high ion pump current is available for installation
 - Verification Gas Assembly (ORU8) not installed
 - VGA removed from Node 3 MCA that has intermittent leak is available for installation
- Node 3 MCA
 - Status: **Operational**
 - ORU 1 is installed (running “old” firmware (v4.18) and “old” style EDP card)
 - ORU2 S/N F0005 was installed on 23 Jan 12
 - No issues with filament failures which has affected two previous mass spectrometers
- Evolution Needs:
 - Improved reliability, reduced size, and improved accuracy for mass-spec based air monitor = extensible air monitor for all exploration elements and all candidate operating conditions
 - Pursuing early development of the Orion Air Monitor as a potential replacement for MCA



Major Constituent Analyzer
(MCA)



ECLSS Capabilities for Exploration



- ECLSS Roadmap developed by cross-Agency Thermal/ECLSS Steering Committee
 - Utilized functional decomposition to identify gaps in current ECLSS capabilities based on expected operational duration and gravitational environments for beyond-LEO Exploration missions
 - Three teams of ECLSS experts representing ARC, GRC, JPL, JSC, KSC, MSFC performed the functional gap assessments for atmosphere management, water management, and solid waste management
- Recommendations include
 - Current system designs can be utilized as reference starting points
 - Prudent modifications to those system designs driven by Exploration Mission specifics
 - Improvements to achieve higher reliability are a general enabler
 - Sortie mission elements can start from the Orion ECLSS reference design
 - Long duration mission elements can start from ISS ECLSS reference design



ECLSS Advancement Utilizing ISS



- Current ISS activities align with Roadmap recommendations
 - Amine swingbed payload on-orbit demonstration
 - Urine precipitation prevention
 - Orion air monitor development (potential MCA replacement)
 - Redesigned CDRA sorbent beds with more robust sorbent materials and improved dusting containment
- Proposed activities (also aligned w Roadmap) in work include
 - OGA reliability improvements & simplification
 - High Pressure O₂ recharge capability for EVA usage
 - Onboard trace contaminant monitoring capability (eliminate need for return samples)
 - No-moving parts urine separator concept demonstration
 - Microbial monitor capability demonstration (eliminate need for return samples)
 - Water recovery reliability, recovery, and reduced expendables
 - Alternate urine pretreatment
 - Low crew time, on-orbit air & water quality monitoring capability demonstration



Prioritizing ECLSS Capability Maturation Using ISS



- **Priorities to be further defined through operational data analysis**
 - Cost of technologies and modifications proposed will be weighed against projected improvement of
 - Reduction in initial upmass/system size
 - Reduction in crew maintenance and repair time
 - Reduction in expendables
 - Reduction in spares required/improved reliability
 - Reduction in complexity



ISS Program Focus Summary



Tactical

- SpaceX-1 first Commercial Resupply Service (CRS) flights and Orbital Demo
- HTV 3 launch and cargo exchange
- Increase crewtime & resources for utilization
- Expand ISS Utilization to include National Laboratory and Technology Development and Demonstration
- Commercial Crew Integration

Strategic

- Increase utilization of ISS as a National Lab
- Technology development and demonstration
- Increase utilization on ISS as a test bed for exploration
- Crew transportation plan
- Technical analysis & planning of ISS life extension



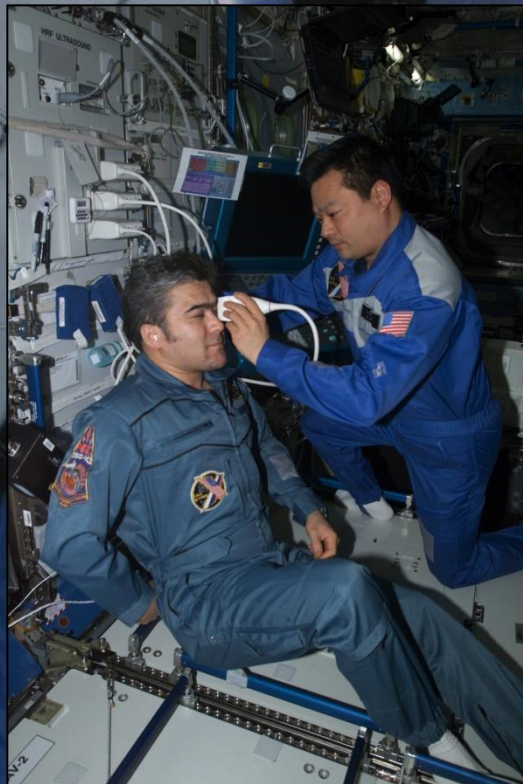


Back Up

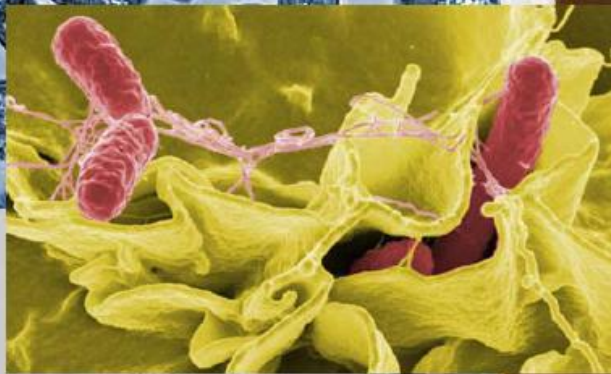
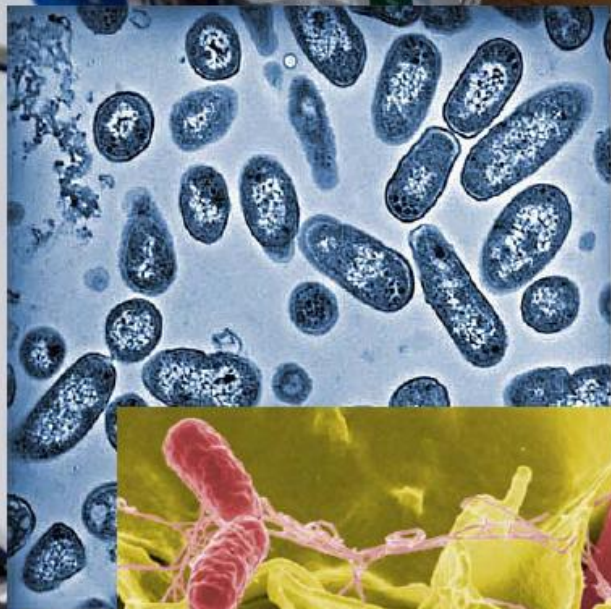
A woman with dark, curly hair that is floating and expanding in a microgravity environment, likely the International Space Station. She is wearing a blue long-sleeved shirt and holding a pair of wooden chopsticks. The background shows the interior of the space station with various equipment, cables, and storage compartments.

Human Health

Maintaining Bone Health through Nutrition – Results from the Nutrition Study on the *International Space Station*, bed rest analogs, and laboratory cellular experiments have shown that Omega-3 fatty acids counteracted bone loss, indicating that diet changes to include more fish may protect bone loss both in space and on Earth. Studies have also identified a loss of Vitamin D as a concern for spaceflight, leading to recommendations for increased intake in astronauts. This recommendation was considered in the latest USRDA recommendation to increase Vitamin D intake for all Americans.



Telemedicine Advancements - Ultrasound training methods developed for evaluating medical issues on the *International Space Station* have been used by the American College of Surgeons to teach ultrasound techniques to surgeons. Additional applications could include diagnosis of injuries and illnesses in remote locations on Earth, including rural areas, disaster areas and the battlefield.



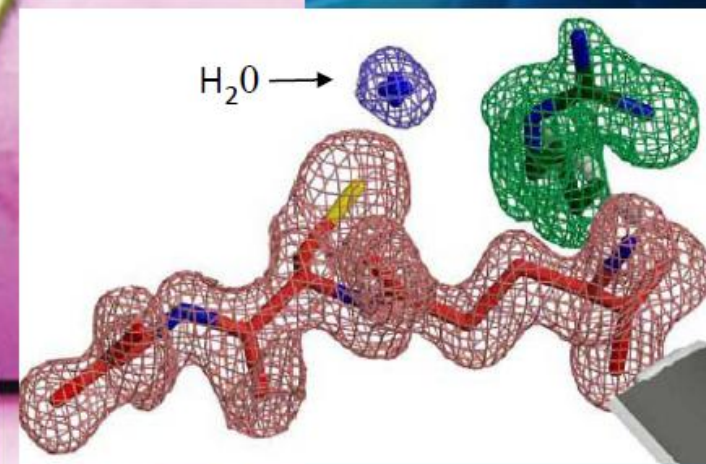
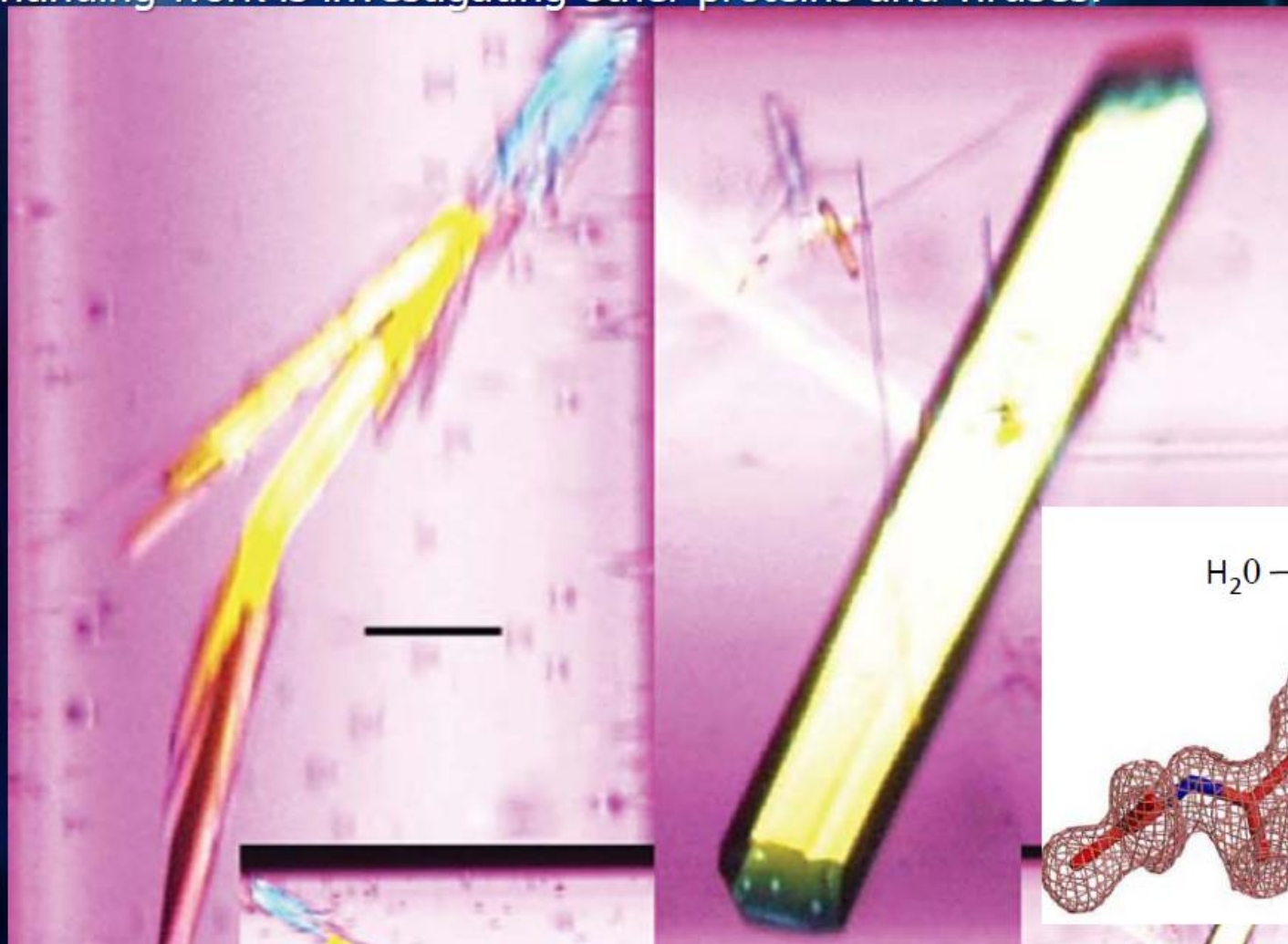
Microbial Vaccine Development – Scientific findings from *International Space Station* research have shown increased virulence in *Salmonella* bacteria flown in space and identified the mechanisms responsible. AstroGenetix, Inc. has funded their own follow-on studies on ISS and are now pursuing approval of a vaccine as an Investigational New Drug (IND) with the FDA. They are now applying a similar development approach to the methicillin-resistant *Staph aureus* (MRSA). In a separate initiative, the Arizona State University Biodesign Institute is studying a recombinant vaccine for pneumonia to see if observations in space can help to increase the efficacy of a vaccine already in clinical trials.

Crew Earth Observations — Photographs taken from the *International Space Station* document global change, weather and geological events and urban growth. Researchers study the volcanic and tectonic activity of the Marianas islands in the western Pacific Ocean.



Earth Observation & Disaster Response

Macromolecular Crystallization— Japanese scientists crystallized a human prostaglandin D2 synthase-inhibitor complex (H-PGDS/HQL-79 complex) on the *International Space Station*, identifying an improved complex structure and an associated water molecule that was not previously known. The H-PGDS protein has shown to play a critical role in the formation of Duchenne's muscular dystrophy. Continuing work is investigating other proteins and viruses.



Disaster Response Networks – The space station offers a unique vantage for observing the Earth's ecosystems with both hands-on and automated equipment. A suite of remote-sensing instruments onboard the **International Space Station** can provide useful images for use in disaster monitoring and assessment, and environmental decision making.



Aurora Max— For Coordinated Aurora Photography from Earth and Space (AuroraMAX), crewmembers photograph the aurora borealis from the International Space Station (ISS). The photography may be timed with periods of increased solar activity to increase the chances of photographing auroras. This is a public outreach initiative designed to inspire the public to learn more about solar-terrestrial science and how solar activity affects Earth.





Education – Students from around the world talk to astronauts each week onboard the ISS through the “Amateur Radio on the International Space Station” program- a cooperative venture of NASA, the National Association for Amateur Radio, and AMSAT.

Source: ISS Program Scientist, NASA

Image courtesy of ARISS



International Space Station - SpaceX-1



SpX-1

• Launch

- NET: 10/5/12
- Program official: 9/24/12

• Cargo

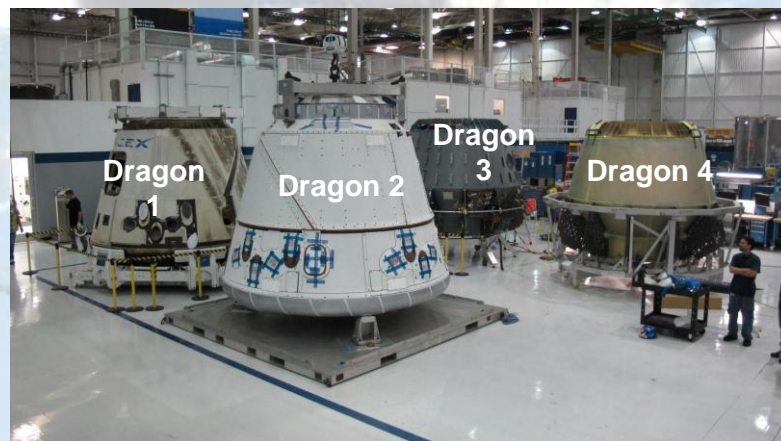
- 1 Orbcomm satellite (150kg) + ISS related pressurized cargo
- 500 kg of return cargo

• Status

- Launch vehicle completed successful static fire tests in April and shipped to the Cape in early May
- Completed Light Intensification Detection and Ranging (LIDAR)/Thermal Imager alignments and Space Integrated GPS (Global Positioning System) INS (Inertial Navigation System) (SIGI) checkouts
- The Thermal Control System (TCS) and Avionics attachments in the Guidance, Navigation & Control (GNC) bay was completed in May
- GNC bay Door is being prepared for installation into the capsule
- Closeouts, inspections, and MLI installation on the forward frustrum was completed in May
- Preliminary Radio Frequency (RF) system testing with all 3 Communication Remote Input/Outputs (Comm RIOs) was completed in May
- Capsule and trunk ready to ship to Cape in late July
- Stage Test added to the schedule for the week prior to the Post Qualification Review (PQR)
- SpX-1 PQR is scheduled for mid-September
- First Dragon flight with late load capability – loading scheduled for 3 days prior to launch

• Completed SpX-1 milestones

- Authority to Proceed
- Vehicle Baseline Review
- Mission Integration Review
- ISS Integration
- Cargo Integration Review



Dragon Hive: Dragons 1 – 4

Photo Credit:
SpX



International Space Station - SpaceX-2



SpX-2

- **Launch**
 - NET: 1/18/13
 - Program official: 12/15/12
- **Cargo**
 - External cargo: Two (2) Heat Rejection Subsystem Grapple Fixtures (HRSGF) – Grapple Bars to be installed to MBS and POA
 - 1 Glacier – powered double mid-deck lockers (launch and return)
 - 3 Cold Bags Up & 5 Cold Bags Down
- **Status**
 - First Stage engine section assembly shipped to McGregor in May
 - Second Stage in final assembly and will ship to Texas in July
 - SpaceX delivered the SpX-2 Interface Control Document (ICD), integrated Computer Aided Design (CAD) model and release mechanism shock data
 - Draco thrusters build is complete for Dragon 4
 - Final NBL run is planned for July
 - JSC/DX (Robotics) completed Dragon Demo trunk survey to prepare for SpX-2 ops
 - Grapple Bar tie down plan completion is planned for July (this will determine if 2 additional cold bags can be flown)

• Completed SpX-2 milestones

- Authority To Proceed
- Vehicle Baseline Review
- Mission Integration Review
- External Cargo Baseline
- External Integration Review



Photo Credits: SpaceX



International Space Station - Orbital-1



Orb-1

- **Launch**
 - NET: 2/12/13
 - Program official: 4/08/13
- **Cargo**
 - Planning pressurized cargo complement of 1575 kg
- **Status**
 - 0000.4 Core now planned for Orb-1
 - Castor 30B cast and exit cone machining complete
 - Engines 10 and 5 now planned for Orb-1; E10 ATP and delivery to WFF planned for September; E5 ATP in September with delivery to WFF in October
 - SM second shock test successfully performed in May using configuration designed to match expected on-orbit accelerations
 - PCM-1 in transportation container for leak check activity with delivery to WFF in late August
 - Final Integrated Systems Test (FIST) activity began in mid-June and is on-going with completion planned for the end of August

• Completed Orb-1 milestones

- Authority To Proceed
- Long Lead Order Placement
- Vehicle Baseline Review
- SM Propulsion Sys Manufacturing Readiness Review
- Mission Integration Review
- Service Module Integration and Test
- Receipt of Long Lead Items

Cygnus Demo and Orb-1 Service Modules



Photo Credits: OSC



SpaceX Demonstration Mission



❑ SpaceX Demo Mission Ops team

- The Relative Global Positioning System (RGPS)/Commercial Orbital Transport Services (COTS) Ultra High Frequency (UHF) Communications Unit (CUCU) link was established early by better than expected Dragon and ISS antenna performance
- The Dragon was unable to establish consistent high data rate communication with TDRSS. A joint ops workaround modified the timing to transition from one TDRSS to the next
- The SpaceX team was able to reduce ISS CUCU transmit power below pre-flight predictions through real-time monitoring. This allowed the team to prevent saturating the Dragon CUCU receiver prior to the Approach Initiation (AI)
- The Thermal Imager tracker algorithm showed a range bias greater than expected. SpaceX changed the limits allowing Dragon to continue R-bar ascent. Range bias returned to pre-flight limit at 130m
- LIDAR filter faulted three times during R-bar approach. SpaceX reduced LIDAR gain settings and cropped the LIDAR images to allow the vehicle to approach safely



The Dragon vehicle on approach to the ISS



Dragon successfully grappled by ISS SSRMS on 5/23

Photo Credits: SpaceX



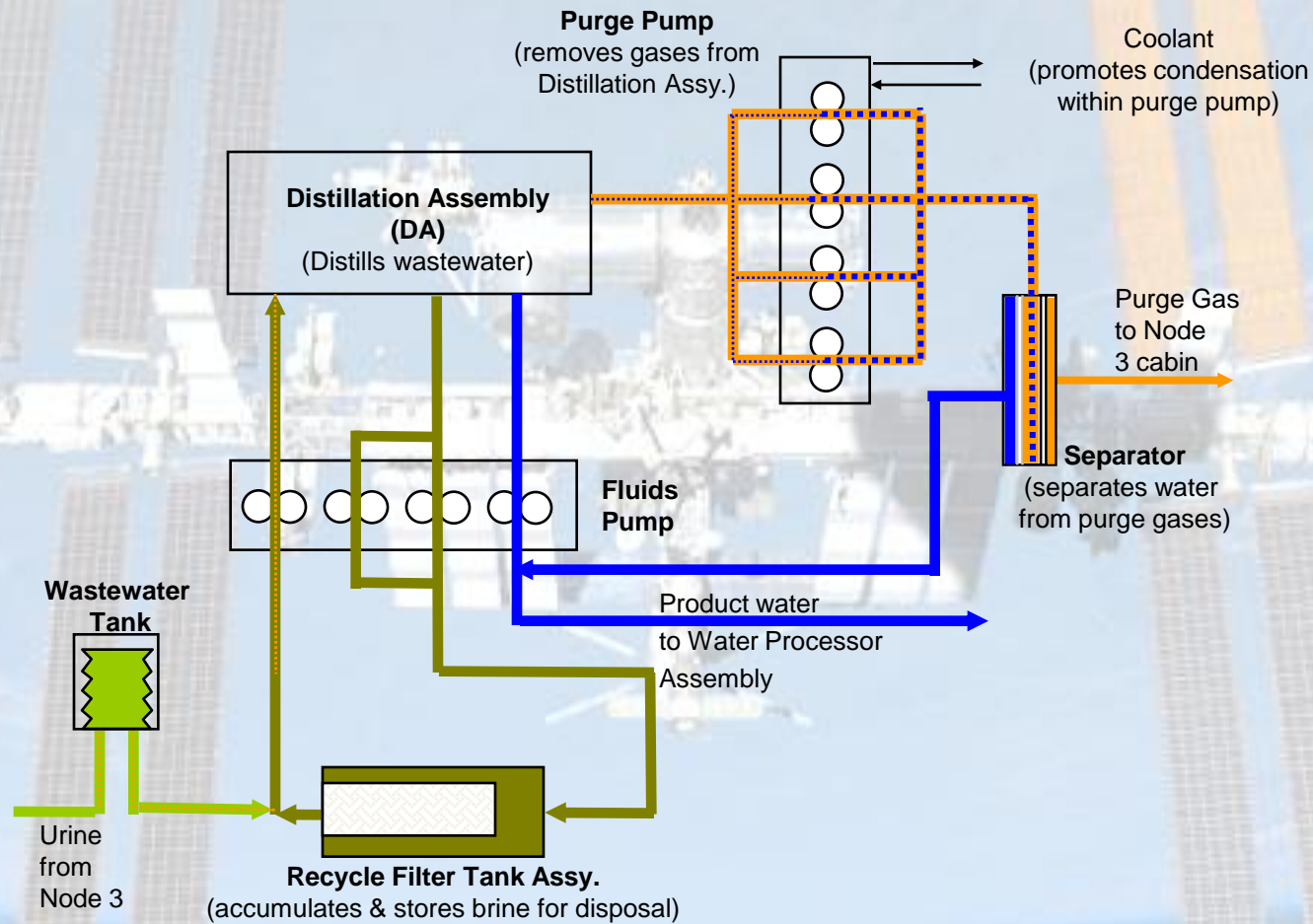
ISS Commercial Crew Integration Support



- Subsystem teams working with the Commercial Crew Program (CCP) to validate the verification requirements in the joint ISS Crew Transportation and Services Requirements Document (CCT-REQ-1130)
- Provided briefing to the CCP Program Control Board on the C2V2 strategic plan for CCP Partner integration and interface testing requirements
- Supported the International Docking Adapter (IDA) Interim Design Review (IDR)
- Coordinated proposed IDA orientation configurations as installed on the Node 2 forward docking port (PMA2) with commercial providers. Updating the ISS interface requirements document to incorporate this new configuration
- Supported the subsystem Preliminary Design Review (PDR) on the NASA Docking System in February
- Recently supported CCP Partner milestone reviews:
 - Boeing Software PDR was held on 5/7
 - SpaceX held a successful crew trial for the Spacecraft on 4/25 and a Launch Abort System Test Component Readiness Review on 5/15
 - Sierra Nevada Corporation held their Integrated System PDR on May 3-5 with the final PDR board planned for 5/30
 - Blue Origin Systems Requirements Review (SRR) was held on 5/14
 - ATK held a Technical Interchange Meeting (TIM) to discuss the abort certification and approach; ATK announced spacecraft provider and held system design review in May

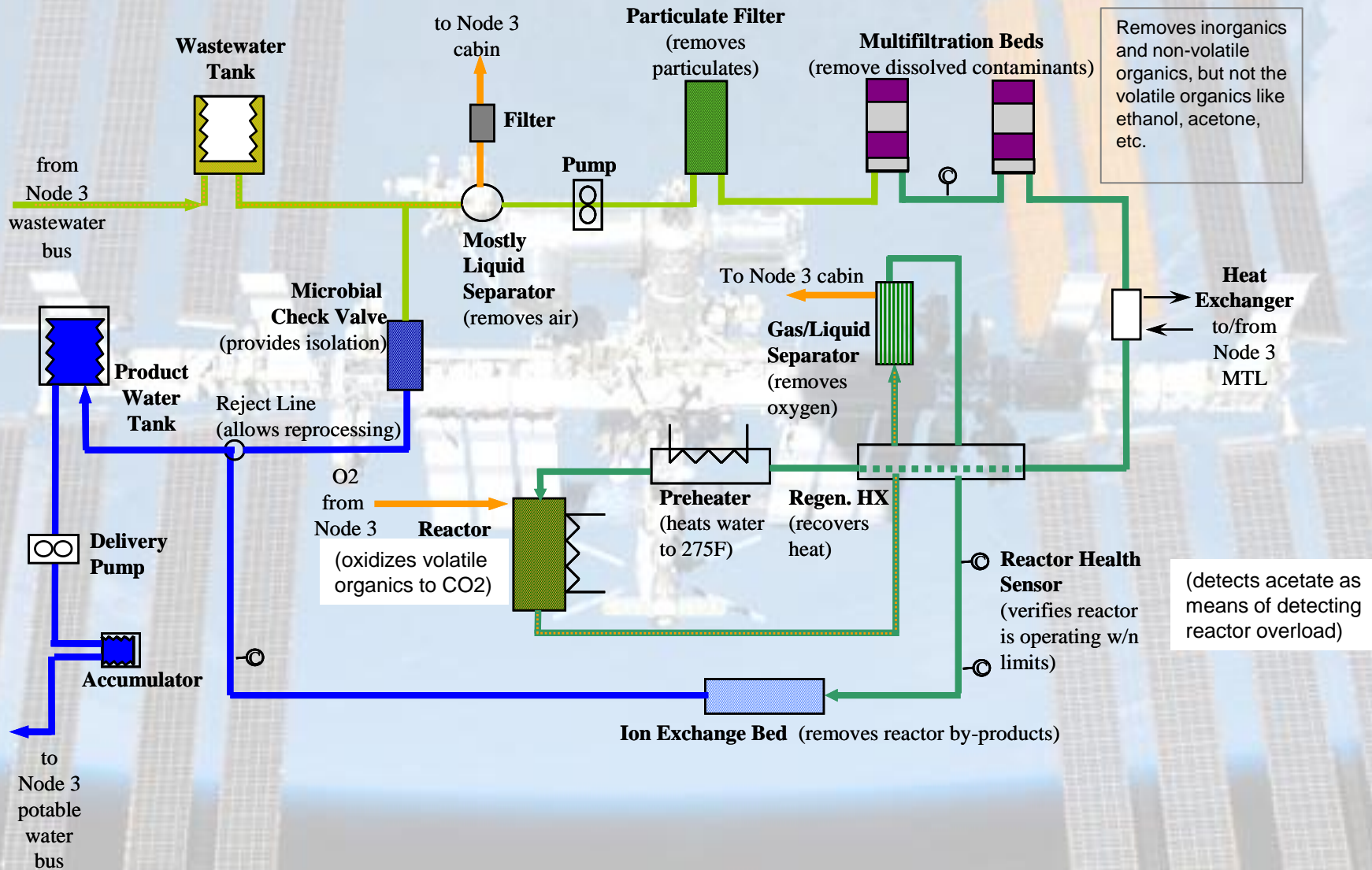


UPA Schematic



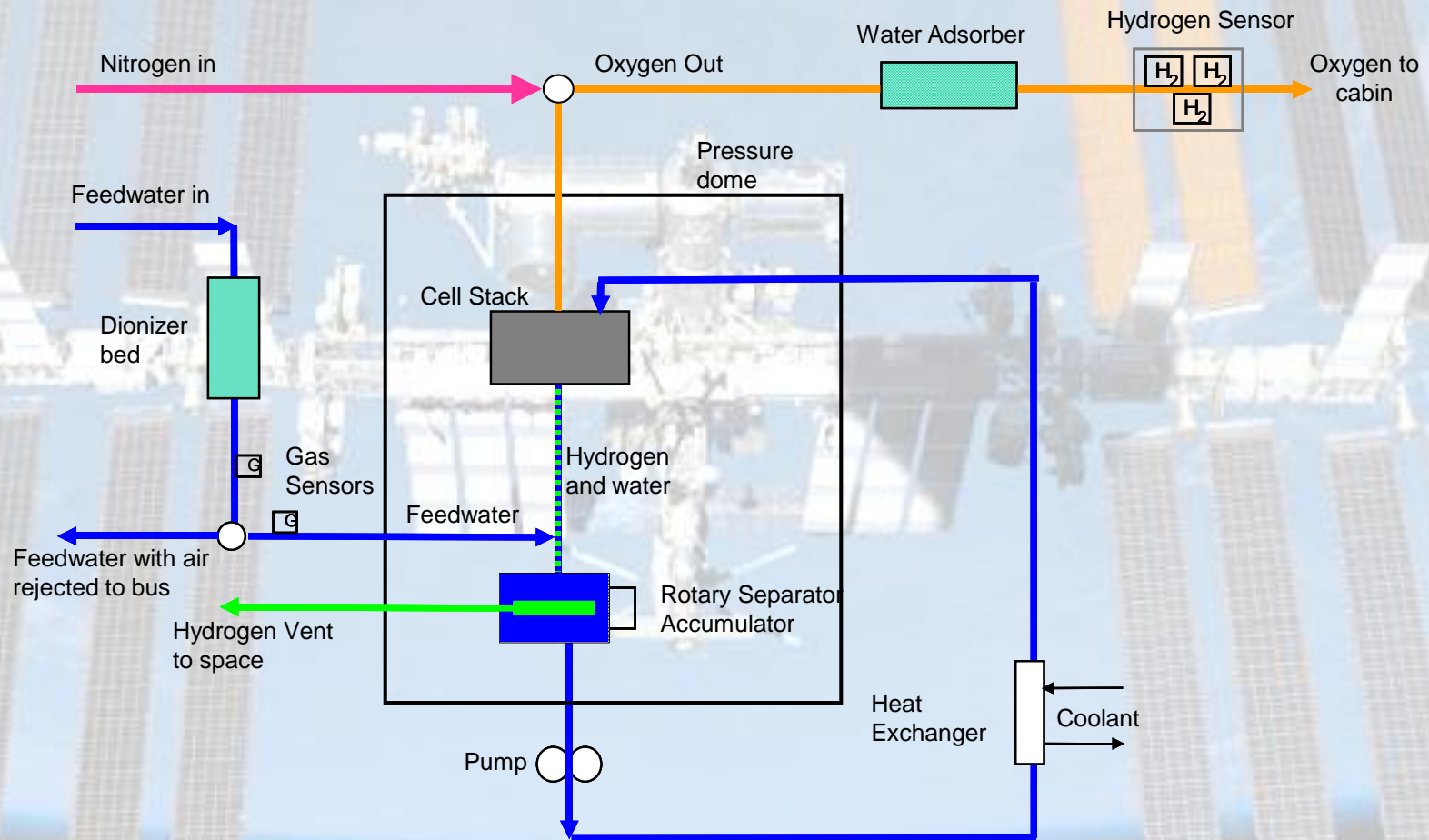


WPA Schematic



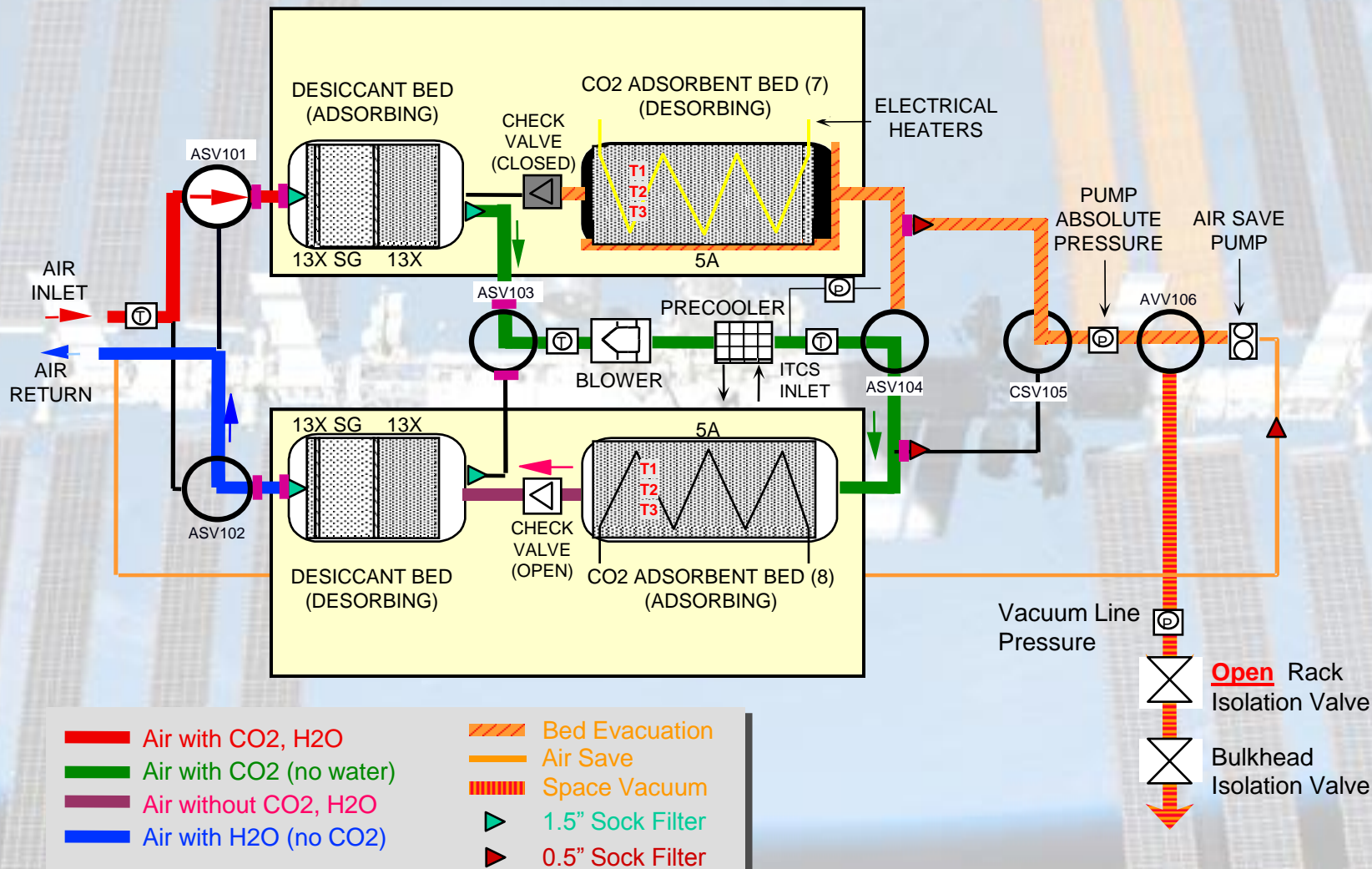


OGA Schematic



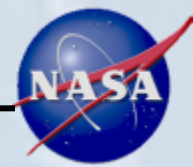


CDRA Schematic

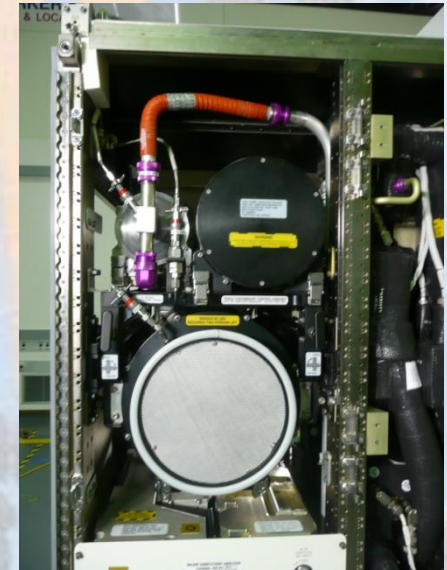




Trace Contaminant Control System



- Trace Contaminant Control System (TCCS)
 - Status: Operational
 - Flight charcoal bed life exceeds original design prediction (12X)
 - Issues – sorbent material obsolescence
 - Currently have enough in bonded storage for life of ISS, but must continually evaluate shelf life
- Evolution Needs:
 - Newer available sorbents could enhance TCCS performance, reduce size as well as solve obsolescence issue



Trace Contaminant Control System